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Prevalence of Foodborne Diseases in Europe

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Glossary

Disability-adjusted life years It provides a measure of overall disease burden, expressed as the number of years lost due to ill health, disability, or early death.

Foodborne source attribution Refers to the process of partitioning foodborne infections by specific sources, where the term 'source' can include the animal reservoirs or food vehicles.

Meta-analysis Refers to the process of estimating the true effect size from pooled results of, for example, case–control studies, as opposed to the less precise result obtained from a single study under a given single set of assumptions and conditions.

Reservoir Refers to the animal hosts (including humans) from which foodborne pathogens originate. The reservoir can include diseased or asymptomatic carriers/shedders.

Systematic review Refers to a literature review, which is driven by a research question. The process involves identifying, appraising, selecting, and synthesizing all high-quality research evidence relevant to the research question.

Vehicles These are inanimate objects that enable contact between pathogen reservoir and people and include water, food, animals, soil, manure, compost, and other people.

Introduction

Foodborne disease kills people. Reminders of this chastening fact include the devastating outbreak of *Escherichia coli* O104:H4 in Germany in 2011, in which 54 people died and 22% of the 3186 cases of *E. coli* O104 developed the severe complication, hemolytic uremic syndrome (HUS). Outbreaks are striking events, yet the percentage of all cases of foodborne disease that occur as part of outbreaks is fairly small. The first port of call when seeking to understand the prevalence of foodborne disease is the official bodies that have responsibility for monitoring illness in the population. However, the datasets amassed by these organizations tend to underestimate the population burden of illness so, in the past decade or so, there has been a proliferation of new methods across Europe in an attempt to overcome this deficiency and develop better estimates of the true population burden of illness.

The Prevalence of Foodborne Disease in Europe: The Official Estimates

The major sources of collated data on the prevalence of foodborne disease in Europe are the World Health Organization (WHO) Regional Office in Europe and the European Center for Disease Prevention and Control (ECDC). The WHO program covers 53 countries that make up the WHO European Region – from the Republic of Ireland in the West to the Russian Federation in the East, and Israel to the South. The ECDC compiles data from the 27 Member States of the European Union (EU) and three European Economic Association/European Free Trade Association countries. In addition, the European Food Safety Authority (EFSA) is responsible for analyzing data on zoonoses, antimicrobial resistance, and foodborne outbreaks submitted by EU Member States for preparing the EU Summary Report. This is undertaken in collaboration with the ECDC.

The View from the WHO Regional Office in Europe

In 2002, World Health Assembly mandated WHO to develop a global strategy for reducing the burden of foodborne disease. In this strategy, it is recognized that preventing foodborne disease and responding to food safety challenges need a timely, holistic, risk-based approach.

Information about the prevalence of foodborne disease in the WHO European Region is available from the Centralized Information System for Infectious Diseases (CISID). The CISID dataset, compiled from national reports, is underpinned by accurate and up-to-date population data for the WHO European Region and information collected by WHO is useful for risk assessment.

The CISID dataset covers a wide range of foodborne pathogens. In the WHO European Region, salmonellosis and campylobacteriosis are the most commonly reported foodborne diseases. Between 2000 and 2010 the highest incidence of campylobacteriosis was consistently reported from the

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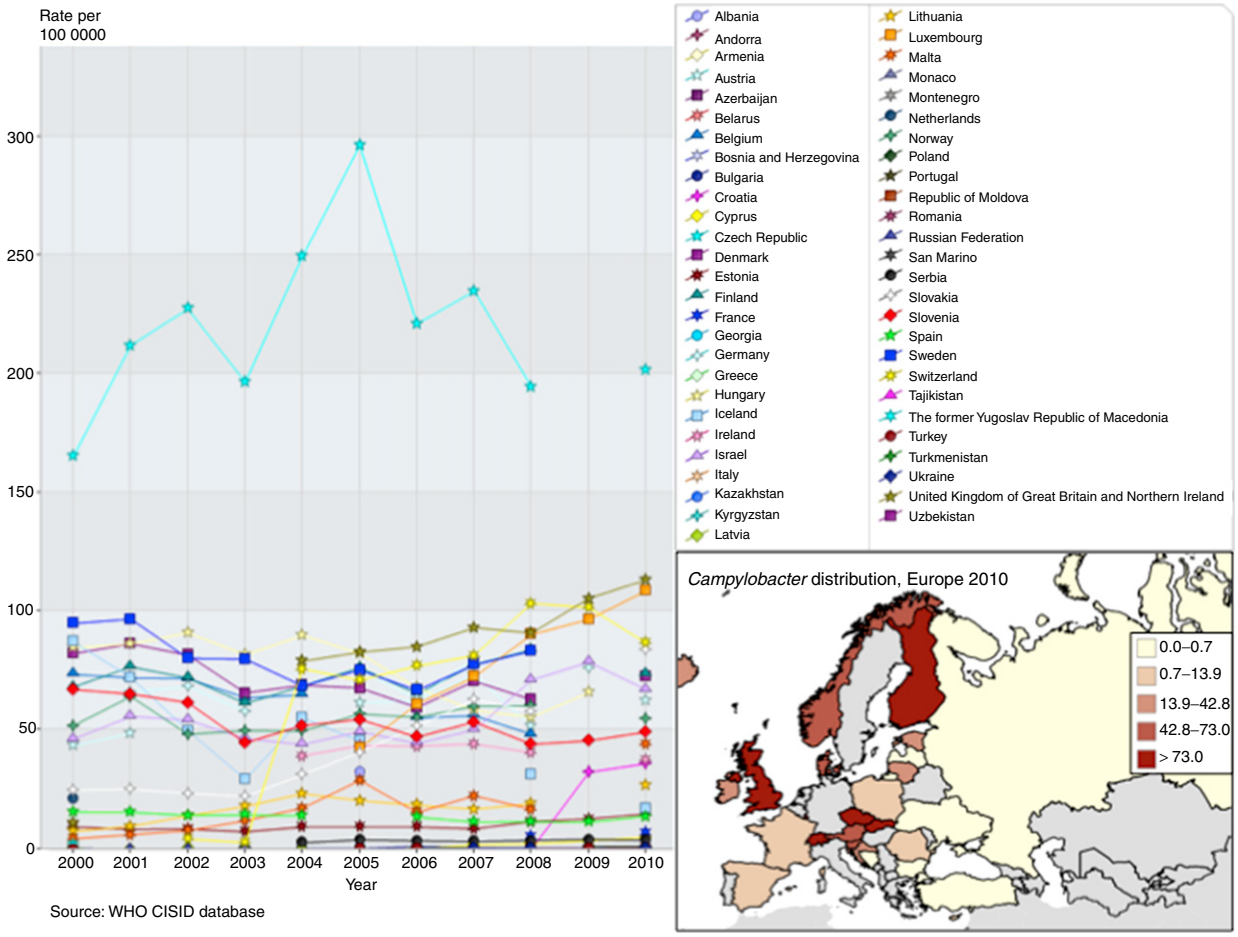

Figure 1 Trend in campylobacteriosis in the WHO European Region, 2000–10.

Former Yugoslav Republic of Macedonia, where rates were almost three times as high as elsewhere in the region (Figure 1).

The incidence of salmonellosis declined over the decades 2000–10 in several countries although *Salmonella* was still a frequent cause of the foodborne outbreaks (Figure 2).

The trend in listeriosis remained relatively stable over the decades 2000–10 (Figure 3), but reporting of enterohemorrhagic *E. coli* (EHEC) was mainly from Western European countries (Figure 4).

Brucellosis remained a significant public health problem in the Central Asian republics. Trichinellosis in the Balkan countries and echinococcosis in both the Central Asian republics and the Balkan countries were causes for concern. Botulism remained relatively frequent in Eastern Europe and is mainly related to traditional ways of preserving foods at home.

The View from the ECDC

Established in 2005, the ECDC is a EU agency that aims to strengthen Europe's defenses against infectious diseases. The Programme on Food- and Waterborne Diseases and Zoonoses was instituted in 2006, and covers a comprehensive range of pathogens. Early priorities included consolidating surveillance for salmonellosis, campylobacteriosis, verocytotoxin-producing *E. coli*/shiga toxin-producing *E. coli* (STEC) infection, listeriosis, shigellosis and yersiniosis; publication of an annual zoonosis report jointly with the EFSA; and developing novel methodology to estimate population exposure to salmonellosis and campylobacteriosis using seroepidemiology. In its 2011 annual epidemiological report, ECDC reported that *Campylobacter* rates are high and it remains the most commonly reported gastrointestinal illness across the EU. In 2009, there were over 201 000 confirmed cases (rate = 53 cases per 100 000 population). The highest rates were reported from the Czech Republic (193 cases per 100 000) and the UK (106 cases per 100 000).

By contrast, the incidence of *Salmonella* infection has decreased progressively since 2004 and this has been linked, at least partly, to effective programs to control infection in the poultry industry. There were over 111 000 cases reported in 2009 (rate = 23 cases per 100 000 population) and *Salmonella* continues to be a common source of outbreaks. *Salmonella* Enteritidis and *Salmonella* Typhimurium remain the most frequently identified serotypes but rates of *S.* Enteriditis infection were 24% lower in 2009 than in 2008 and rates of *S.* Typhimurium had also declined by 12%. Even in the higher incidence countries like the Czech Republic, Slovakia, Hungary, and Lithuania rates have also decreased markedly.

Reported cases of EHEC increased significantly between 2005 and 2009 to just over 3600 cases (rate = 0.86 per 100 000

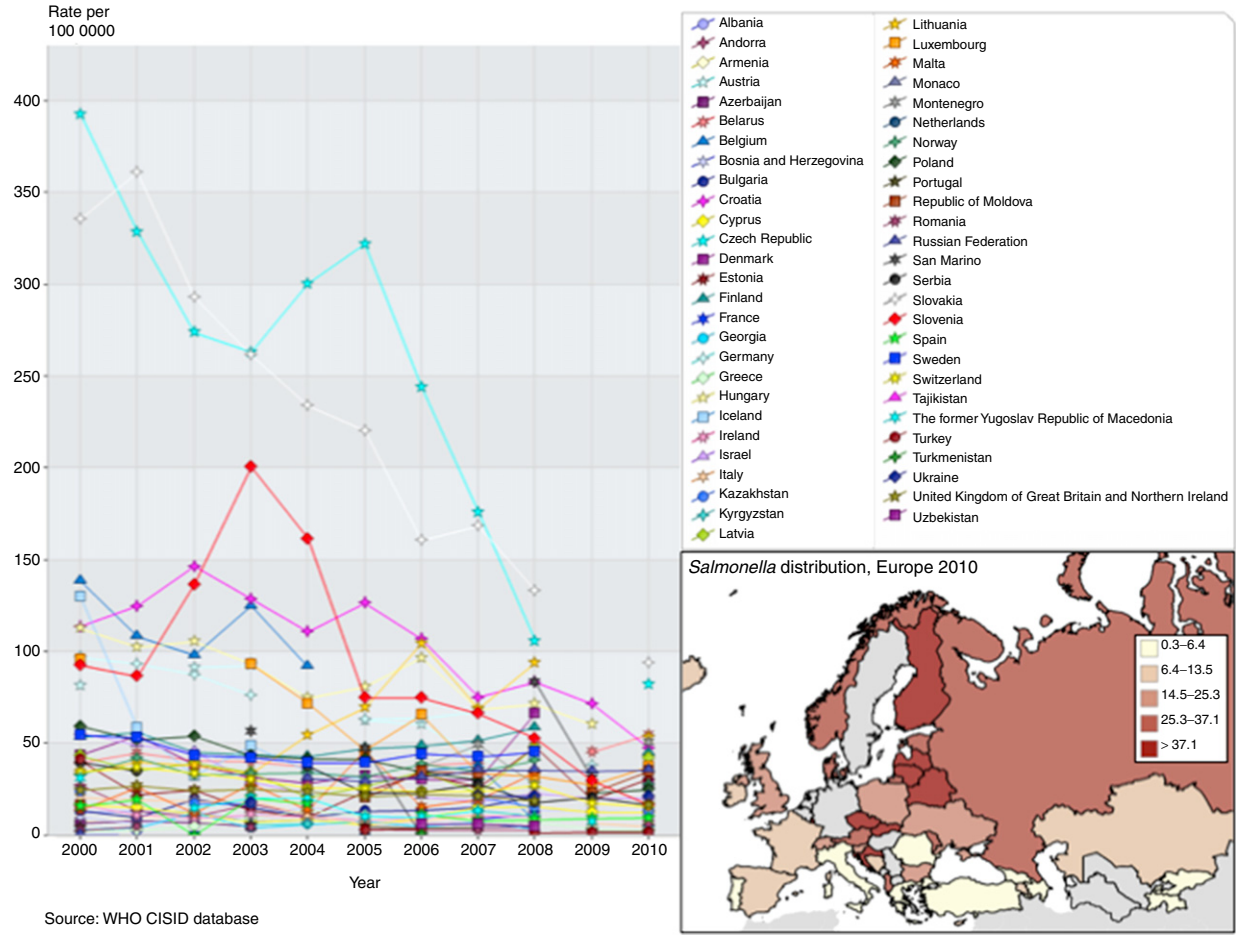

Figure 2 Trend in salmonellosis in the WHO European Region, 2000–10.

population). More than half of the cases were due to STEC O157. There were 242 confirmed STEC cases that developed HUS – a 66% increase in HUS cases compared with 2008. This large increase was, in part, explained by two sizable outbreaks of STEC – one in the UK linked to an open farm and a nationwide outbreak in the Netherlands associated with the consumption of STEC-contaminated beef steak tartare.

The ECDC report shows that some rare or uncommon gastrointestinal infections EU-wide can, nevertheless, affect particular subregions and countries. Brucellosis is reported mainly from Portugal, Spain, and Greece, where it is associated with goat farming. The majority of trichinellosis cases occurred in Bulgaria, Romania, and Lithuania, where it is likely to be associated with eating domestically reared pork and wild boar, and most confirmed echinococcosis cases were from Bulgaria, where increasing proportions of *Echinococcus*-positive cattle and sheep are also being reported. Overall, yersiniosis rates were decreasing but remain high in the Nordic states, Germany, the Czech Republic, and Slovakia, where infection is often associated with pork consumption. Confirmed case rates for listeriosis were highest in 2009 in Denmark (rate = 1.8 cases per 100 000 population), which has experienced a marked increase in cases, especially in people over 70 years of age. The increase was attributed, at least in part, to a surge in consumption of ready-to-eat (RTE) products in Denmark, especially in older people. A similar pattern was witnessed in the UK, where a doubling in cases of listeriosis in people aged more than 60 since 2001 was attributed to a combination of greater consumption of RTE products like sandwiches coupled with an increase in underlying medical conditions like cancer, requiring complex, immunosuppressive treatment.

The View from the EFSA

The EFSA, in collaboration with the ECDC, produces an annual 'European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Foodborne Outbreaks.' In 2010, there were 5262 foodborne outbreaks reported in the EU – similar to the level reported in 2009. These outbreaks involved nearly 43 500 people, of whom approximately 4600 were hospitalized and there were 25 deaths. The evidence implicating a food vehicle was considered to be strong in 698 outbreaks.

Salmonella was the most frequently reported pathogen (30.5% of all outbreaks), followed by viruses (15.0%) and *Campylobacter* (8.9%) (Figure 5). However, there was a considerable proportion of outbreaks in which the causative

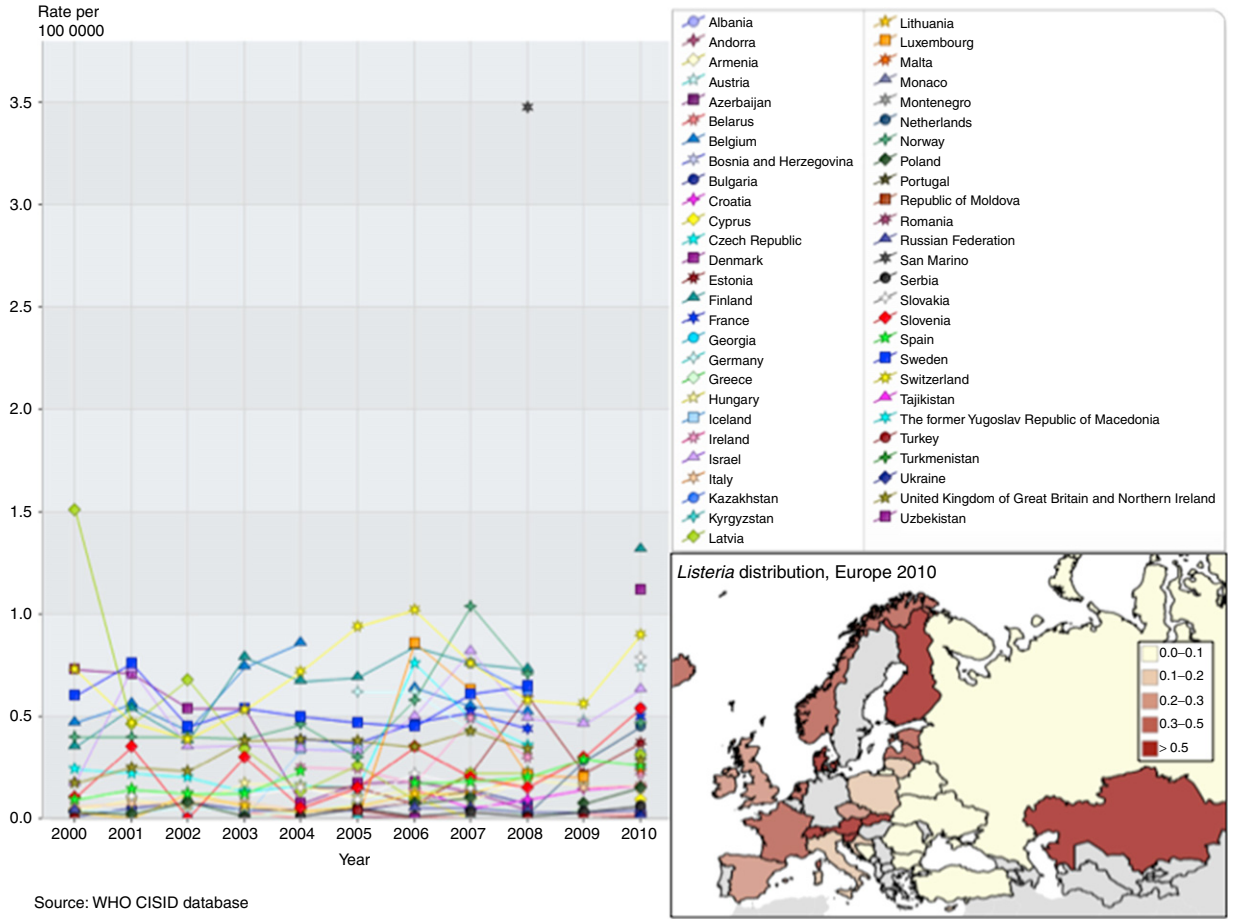

Figure 3 Trend in listeriosis in the WHO European Region, 2000–10.

organism was unknown and a large percentage of *Campylobacter* outbreaks in which the evidence implicating a food vehicle was considered to be weak.

The most frequently reported food vehicles were eggs and egg products (22.1%); mixed or buffet meals (13.9%); vegetables, juices, and vegetable/juice products (8.7%); and crustaceans, shellfish, molluscs, and shellfish products (8.5%). An increase in the numbers of reported outbreaks caused by vegetables and vegetable products was attributed mainly to contamination with viruses.

The View from 'NoroNet'

It is becoming increasingly apparent that norovirus (NoV) is an important foodborne pathogen. Contamination can occur either at primary production, for example, shellfish, salad vegetables, and soft fruits at source or, at retail, for example, through inadequate practises by infected food handlers. Funded initially through a research grant, 'NoroNet' now comprises a voluntary collaboration between virologists and epidemiologists from 13 European countries who have been sharing surveillance and research data on enteric virus infections, mainly NoV, since 1999. There are international partners from North America, Australia, China, India, and New Zealand. The objectives of NoroNet include providing better estimates for the proportion of foodborne NoV infections and determining the high-risk foods associated with illness. Several publicly available analytical tools have been developed including a 'transmission mode tool' to increase the chances of identifying a foodborne source of infection. Using this tool to analyze 1254 outbreaks from nine countries reported between 2002 and 2006 showed that the proportion of NoV outbreaks that were likely to be foodborne was 22%. 'NoroNet' was also instrumental in identifying the latest pandemic strain – the Sydney 2012 virus, which has recently overtaken all others to become the dominant strain worldwide.

Gaps in Our Knowledge

A major drawback of all surveillance systems, be they local, national, or international, is that they underestimate the true population burden of acute gastroenteritis and, in turn therefore, the true burden of foodborne disease. Surveillance systems eavesdrop on the clinical process. The greatest potential loss of information about illness in the population occurs when people do not access the healthcare system. In most countries, an episode of illness has no chance of being included in surveillance statistics unless the patient consults a doctor or nurse. Similarly, information on pathogens is only available if the doctor or nurse requests, and the patient provides, a sample for laboratory testing.

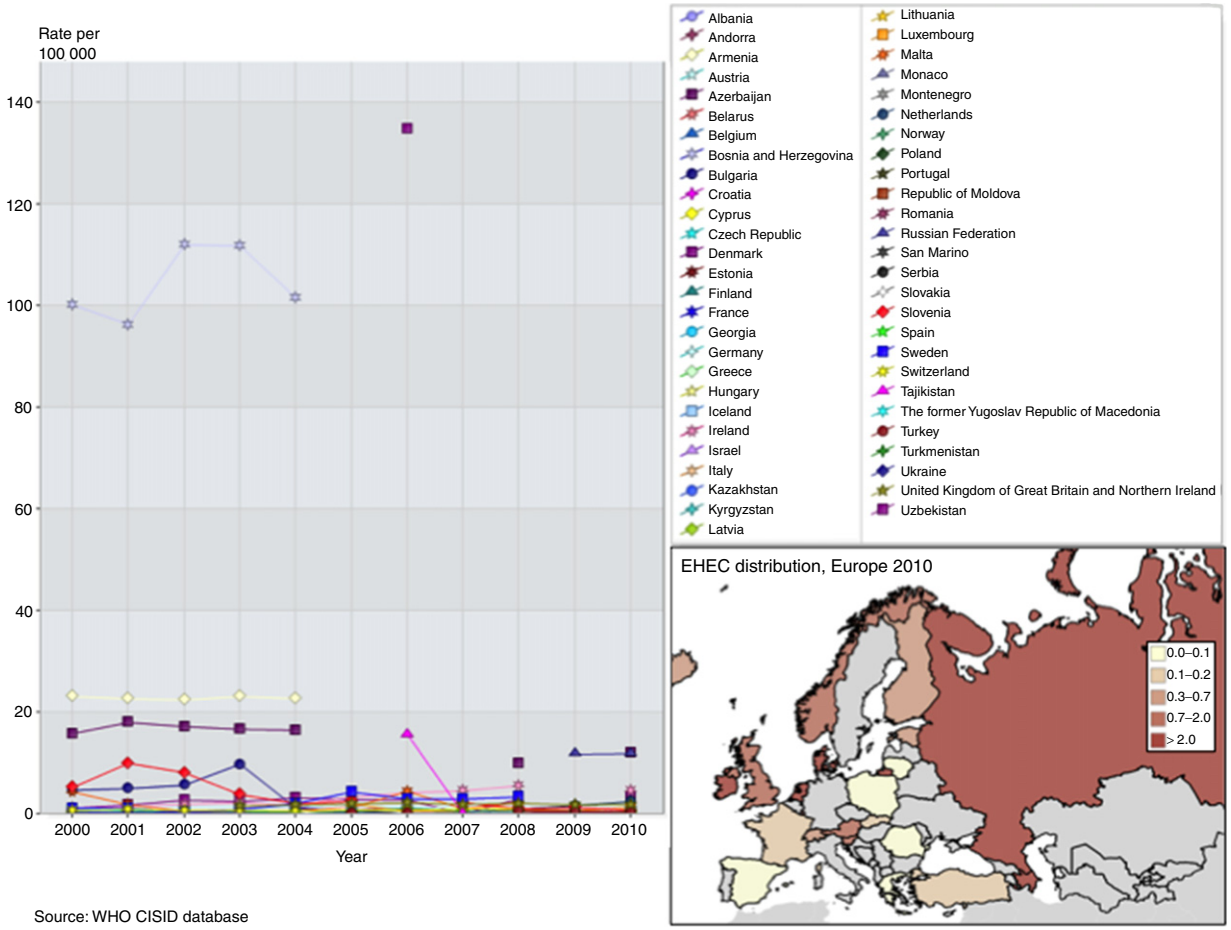

Figure 4 Trend in EHEC infections in the WHO European Region, 2000–10.

National surveillance systems for foodborne disease in Europe operate in different ways. Some are sentinel, symptom-based systems that collect little information on etiology. Others are based on laboratory-confirmed cases of infection. Laboratory testing protocols vary between laboratories within the same country, let alone between laboratories in different countries. Some cover the total population, while others include only a proportion of the total population. Most routine programs are passive, voluntary systems. The degree of underascertainment in many of the systems has not been measured, and all these factors conspire to make meaningful comparisons of disease rates between countries very difficult to accomplish.

The key to determining the real impact of foodborne disease on the population is to understand, first of all, the 'true' population burden of acute gastroenteritis.

Burden of Acute Gastroenteritis

There are several methodological approaches for estimating the incidence of acute gastroenteritis including retrospective cross-sectional surveys (telephone surveys of self-reported illness, door-to-door or postal questionnaire surveys) or prospective, population-based cohort studies (Table 1).

Telephone Surveys

Seven retrospective telephone surveys of self-reported illness have recently been completely performed in the WHO European Region (Table 1). These have the advantage that large samples of the population can be contacted and interviews are relatively short so that participation rates tend to be good. The major disadvantage of telephone surveys and other types of surveys seeking information on symptoms is that the etiology of symptoms is not captured. They are also prone to inaccurate recall, especially if the recall period is fairly long.

Rates of self-reported illness in the general population ranged between 1.4 cases per person per year in Denmark and 0.33 cases per person per year in France. Comparing rates across nations can be difficult. Differences in case definitions, study designs, periods of recall symptoms, and the populations studied can all hamper incidence rate comparisons. For example, one of the studies highlighted in

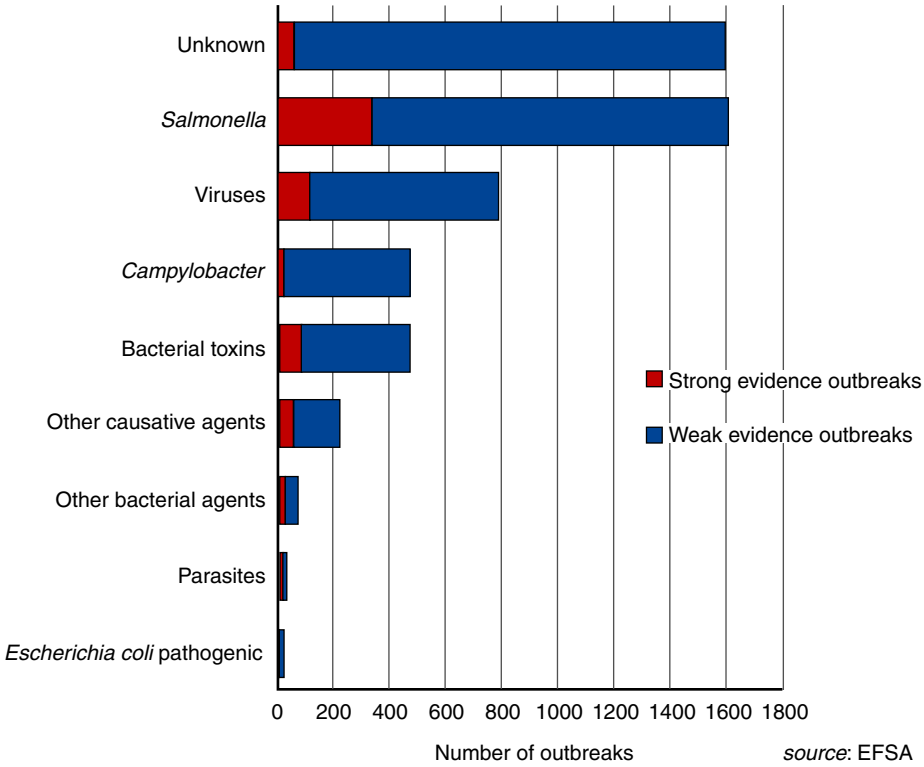

Figure 5 Etiology of foodborne disease outbreaks in the European Union, 2010.

Table 1 Recent population-based studies of the incidence of acute gastroenteritis in Europe

Country	*Study design*	*Study duration*	*Incidence estimate, expressed as rate per person per year (95% CI)*	*Lead author (publication date)*
Poland	Telephone survey	2008–09	0.9 (0.8–1.0)	Baumann-Popczyk *et al.* (2012)
The Netherlands	Questionnaire survey	2009–10	0.96 (0.81–1.11)	Doorduyn *et al.* (2012)
Hesse, Germany	Telephone survey	2004–06	0.86 (0.72–1.03) (children aged ≤15 years) 0.46 (0.37–0.51) (adults aged ≥16 years)	Hauri *et al.* (2011)
Italy	Telephone survey	2008–09	1.08 (0.90–1.14)	Scavia *et al.* (2012)
France	Telephone survey	2009–10	0.33 (0.28–0.37)	Van Cauteren *et al.* (2012)
Israel	Telephone survey	2005	1.49 (not reported) (children aged <17 years)	Ziv *et al.* (2011)
Denmark	Telephone survey	2009	1.4 (1.2–1.6)	Müller *et al.* (2012)
UK	Prospective cohort study	2008–09	0.27 (0.25–0.3) in the community	Tam *et al.* (2012a)

Table 1 only involved children. Nevertheless, using a standardized, symptom-based case definition enabled better comparison of rates between countries, and as the use of this case definition becomes more widespread some of these difficulties in interpreting rates between studies should diminish.

As well as determining disease rates information on healthcare usage in this series of coordinated, cross-sectional telephone surveys of self-reported illness was used to estimate under-reporting and underdiagnosis in the national surveillance systems of the countries taking part. Overall, underreporting and underdiagnosis were estimated to be lowest for Germany and Sweden, followed by Denmark, the Netherlands, UK, Italy, and Poland. Across all countries, the incidence rate was highest for *Campylobacter* spp. and *Salmonella* spp. Adjusting incidence estimates for biases inherent in different surveillance systems provides a better basis for international comparisons than relying on reported data.

Prospective, Population-Based Cohort Study

Prospective studies are uncommon, perhaps because of their expense. Three such studies have been conducted in Europe – one in the Netherlands and two in the UK. The major advantage of cohort studies is the ability to obtain samples from patients with infectious intestinal disease (IID) to confirm etiology, which is important if one of the aims is to calibrate national surveillance systems. A major drawback is that participation rates can be low and losses to follow-up may be high, but there are several strategies to try to overcome both of these important limitations.

In the UK, illness burden has been estimated in a population-based prospective cohort study and prospective study of presentations to primary care (the Second Study of Infectious Intestinal Disease in the Community (IID2 Study)). Up to 17 million people (approximately one in four) in the community were found to be suffering from IID in a year (annual incidence = 0.27 cases of IID per person per year). There were approximately 3 million cases of NoV infection and 500 000 cases of campylobacteriosis. The estimated time taken off from work or school because of IID was nearly 19 million days. Approximately 1 million people presented to their primary healthcare team and the leading causes were NoV infection (130 000 cases) and campylobacteriosis (80 000 cases).

As well as defining illness burden, a secondary objective of the IID2 Study was to recalibrate national surveillance systems, i.e., to estimate the number by which laboratory reports of specified pathogens need to be multiplied to establish the actual number of infections in the community. So, for every case of IID reported to national surveillance centers in the UK, 147 cases had occurred in the community. For *Campylobacter* the ratio of disease in the community to reports to national surveillance was approximately 9 to 1, for *Salmonella* the ratio was approximately 5 to 1, and for NoV the ratio was almost 300 to 1.

Health Economics Assessments

A very powerful way to win the interest of politicians and policy makers is to be able to attach a monetary value to food-related illness. In developed countries, diarrheal disease can be belittled as inconvenient and unimportant alongside noncommunicable diseases like diabetes, heart disease, and stroke. Nevertheless, there can be considerable disruption to society and the economy. For example, the estimated costs of diarrheal disease are in the region of 345 million EUR in the Netherlands, 270 million EUR in Australia, and 2.8 billion EUR in Canada.

Disability-Adjusted Life Years

In the Netherlands, in 2009, the burden of NoV infection alone was estimated to be 1622 (95% confidence interval (CI) 966–2650) disability-adjusted life years (DALYs) in a population of 16.5 million, which is a large amount for what is generally held to be a very mild and self-limiting illness.

Burden of Food-Related Illness

Having worked out the burden of acute gastroenteritis, the next rational step is to apportion illness burden by transmission route, namely foodborne transmission. Once again, several methodologic approaches are available, including epidemiologic and microbiologic approaches, intervention studies, expert elicitation, health economics assessments, and systematic reviews.

Source Attribution Using Outbreak Data

Outbreaks that have been meticulously investigated, i.e., where the evidence linking the outbreak to a food vehicle is strong, can provide useful information for subdividing diarrheal disease by transmission route. However, there are several limitations when interpreting the results. The first is the robustness of evidence incriminating a food vehicle in an outbreak in the first place. For example, in the EFSA Report published in 2010 only 698 of 5262 outbreaks were considered to provide strong evidence of a link to a food vehicle. Second, it has to be accepted that the distribution of food vehicles implicated in outbreaks is the same as the distribution of food vehicles responsible for sporadic cases of infection and this is a major assumption.

In the UK, in an attempt to estimate the impact of disease risks associated with eating different foods, over 1.7 million cases of UK-acquired foodborne disease per year resulted in almost 22 000 people being admitted to hospital and nearly 700 deaths. *Campylobacter* infection caused the greatest impact on the healthcare sector (nearly 161 000 primary care visits and 16 000 hospital admissions) although *Salmonella* infection resulted in the most deaths (more than 200).

In France, it has been estimated that foodborne pathogens cause between 10 000 and 20 000 hospital admissions per year. *Salmonella* is the most frequent cause of hospital admissions, followed by *Campylobacter* and *Listeria*.

Health Economics Assessments

The UK's Food Standards Agency estimates the cost of foodborne illness in England and Wales annually by assessing the resource and welfare losses attributable to foodborne pathogens. The overall estimated cost of foodborne illness annually in England and Wales has remained relatively constant since 2005 at approximately GBP 1.5 billion. For comparison, in New Zealand and the USA the costs are 216 million NZD and 152 billion USD, respectively.

Disability-Adjusted Life Years

In the Netherlands, the foodborne disease burden due to 14 food-related pathogens has been estimated using DALYs. This method for determining disease burden includes estimates of duration and takes into account disability weights for nonfatal cases and loss of statistical life expectancy for fatal cases. In total, there were an estimated 1.8 million cases of diarrheal disease and 233 deaths, of which approximately 680 000 cases and 78 deaths were allocated to foodborne transmission. The total burden was 13 500 DALYs. At a population level, *Toxoplasma gondii*, thermophilic *Campylobacter* spp., rotaviruses, NoVs, and *Salmonella* spp. accounted for the highest disease burden.

Similarly, the public health effects of illness caused by foodborne pathogens in Greece during 1996–2006 have been calculated. Approximately 370 000 illnesses per million people were judged to have occurred because of eating contaminated food. A total of 900 illnesses were found to be severe and three were fatal. The corresponding DALY estimate was 896 per million population. Brucellosis, echinococcosis, salmonellosis, and toxoplasmosis were the most common known causes of foodborne disease and accounted for 70% of the DALY estimate of 896 DALYs per million people.

Expert Elicitation

Expert elicitation employs expert opinion to apportion pathogens according to foodborne transmission or transmission via other routes. An example of this is the Delphi method, which usually involves experts answering questionnaires in two or more rounds. After each round, a facilitator provides an anonymous summary of the experts' forecasts from the previous round as well as the reasons they provided for their judgments. The experts can then modify their earlier answers in response to the replies of other members of their panel. The range of the answers in each round tends to decrease so that the panel will converge toward a 'correct' answer. The Delphi technique is predicated on the basis that forecasts (or decisions) from a structured panel of people are more accurate than those from unstructured groups. Panels do not need to meet in person for the method to work.

Using structured expert elicitation, almost half of the total burden of diarrheal disease in the Netherlands was attributed to food. *Toxoplasma gondii* and *Campylobacter* spp. were identified as key targets for additional intervention efforts, focusing on food and environmental pathways. Not surprisingly, perhaps, a very high proportion of toxin-producing bacteria (*Bacillus cereus*, *Clostridium perfringens*, and *Staphylococcus aureus*) were considered to be predominantly foodborne. By contrast, multiple transmission routes were assigned to the zoonotic bacterial pathogens and protozoan parasite *T. gondii* although the food pathway was considered to be the most important.

Seroepidemiology

An alternative way to assess the incidence of foodborne pathogens is to investigate exposure to them. Pioneered in Denmark and the Netherlands, an approach to studying infection pressure has been developed using serum antibodies to *Campylobacter* and *Salmonella* as biomarkers to estimate seroconversion rates. This shows that infections are much more common than clinical disease, probably because the majority of infections are asymptomatic. A great advantage of this method is that the assessment of incidence is independent of surveillance artifacts. The method confirms that comparing reported incidence between countries can lead to a totally false impression, even within the EU.

Food-Related Illness by Food Commodity

To pinpoint and then prioritize food safety interventions, the burden of food-related illness needs to be allocated to food commodities. Again, several methodologies exist.

Interventions

The most persuasive evidence for the role of contaminated food items probably comes from studies that demonstrate the impact of interventions on human disease burden. For example, in the UK, where two population-based prospective cohort studies have taken place 15 years apart, there has been a marked fall in nontyphoidal salmonellosis in the community. The fall in incidence coincides closely with voluntary vaccination programs in broiler-breeder and laying flocks, and suggests that these programs have made a major contribution in improving public health, demonstrating the success of such concerted, industry-led action.

Natural experiments also illustrate the importance of poultry contamination as a major source of human *Campylobacter* infection. For example, in the Netherlands widespread culling of poultry that took place because of an avian influenza outbreak was followed by a decrease in *Campylobacter* infection in people, particularly in the areas where culling had taken place. Similarly, when contamination with dioxins caused poultry to be pulled from the supermarket shelves in Belgium the incidence of laboratory-confirmed *Campylobacter* infection in people fell.

Microbiological Source Attribution

The main applications of source or reservoir attribution using microbial subtyping have been to *Salmonella* and *Listeria*. Sero- and phagetyping data tend to be used for this purpose. The underlying philosophy is controlling pathogens in the source or reservoir will avert subsequent human exposure, whatever transmission route or vehicle. Comparing results from animal and human surveillance programs provides insights about the major sources of disease in people.

In Denmark, a source attribution model has been developed to quantify the contribution of major animal-food sources to human salmonellosis. This showed that domestic food products accounted for over half of all cases, with over one-third of cases being attributable to table eggs. Nearly a fifth of cases were travel related, and in a similar proportion no source could be pinpointed. Nearly 10% of cases were attributed to imported food products and the most important source was imported chicken. Multidrug- and quinolone-resistant infections were rare in Danish-acquired infection and were caused more frequently by imported food products and traveling abroad.

Source Attribution Using Outbreak Data

Information from well-conducted outbreak investigations can be very useful for the so-called point of consumption attribution as they are gathered at the public health endpoint and can, therefore, be considered to be a direct measure of attribution at the point of exposure. One of the difficulties in using outbreak data, however, is that foods implicated in reported outbreaks are often complex foods, containing several ingredients or food items, any one of which might be the specific source of the pathogen. The method works best for pathogens where outbreaks are relatively common. So, for example, it is more robust for STEC and *Salmonella* than it is for

Campylobacter, because *Campylobacter* outbreaks are rarely recognized. Using EU outbreak data, 58% of *Salmonella* cases that could be allocated to a source were attributed to contaminated eggs and 29% of *Campylobacter* cases that could be allocated to a source were attributed to contaminated poultry. However, for both pathogens the majority of cases could not be attributed to a source, illustrating another limitation of using outbreak data for these purposes.

In the UK, using outbreak data for point of consumption attribution showed that the most important cause of UK-acquired foodborne disease was contaminated chicken and that red meat (beef, lamb, and pork) contributed heavily to deaths. The prioritization exercise that this type of analysis allowed showed that reducing the impact of UK-acquired foodborne disease was mainly dependent on preventing contamination of chicken.

Systematic Review and Meta-Analysis

Several case–control studies of sporadic salmonellosis and sporadic campylobacteriosis have been published, often using different methodologies and conducted in different settings. Systematic reviews consist of a formal process for literature review focused on a specific research question. In a systematic review of case–control studies and meta-analysis of 35 case–control studies of sporadic salmonellosis, traveling abroad, underlying medical conditions, eating raw eggs, and eating in restaurants were the most important risk factors for salmonellosis in the meta-analysis. Similarly, in a systematic review and meta-analysis of 38 case–control studies of sporadic campylobacteriosis, foreign travel, undercooked chicken, consumption of environmental sources, and direct contact with farm animals were all significant risk factors.

In a systematic review and meta-analysis of hepatitis E virus, occupational exposure to swine was found to be a more important route of transmission to humans than eating contaminated pork. This is an important finding requiring further exploration before any public health policy action in relation to food is implemented.

Investigating the Unknown

Most surveillance systems that capture information on etiology elicit information on known pathogens. Yet in the IID2 Study in the UK a known pathogen was assigned to 40% of community cases and 50% of the cases presenting to primary care. In the remainder of the stool samples submitted no pathogen was detected. So what about the rest? There is a number of possible reasons for the high percentage of cases with unknown etiology. First, it is possible that people reported transient changes in bowel habit not caused by IID. Second, these cases might have been caused by organisms not included in the diagnostic algorithms, like enteropathogenic or enterotoxigenic *E. coli*. Third, the cases might have been caused by putative pathogens like enterotoxigenic *Bacteroides fragilis* or *Laribacter hongkongensis*. Several coronaviruses, picobirnaviruses, pestiviruses, and toroviruses have recently been proposed as causes of IID, particularly in children. Whole-genome sequencing techniques, though not yet enabled for widespread use, create enormous prospects for identifying novel pathogens that might be transmitted through the food chain.

Conclusion

Foodborne illness in Europe is an important public health problem no matter what method is used to measure its impact. If success in public health is defined by illness prevented, there is still a long way to go in controlling foodborne disease in Europe.

See also: Foodborne Diseases: Overview of Biological Hazards and Foodborne Diseases; Overview of Chemical, Physical, and Other Significant Hazards

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